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PHYTOPHTHORA ROOT ROT OF SAND PINE

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The fungus, Phytophthora cinnamomi Rands, is a soil-borne pathogen which causes diseases of various types on more than 900 plant species (2, 4, 5, 6, 11, 12). Well known to foresters for its involvement in littleleaf disease of Pinus spp., particularly short-leaf pine (P. echinata Mill.) (2, 3, 11), P. cinnamomi has also played significant roles in the demise of the American chestnut (Castanea dentata (Marsh.) Borkh.) (4), the devastation of some 100,000 hectares (247,000 acres) of jarrah (Eucalyptus marginata Donn. ex Sm.) forests in western Australia (6, 7, 8), and root diseases on a variety of commercially important tree species in forest nurseries in the United States (2, 4, 5).

Ross and Marx (9, 10) reported P. cinnamomi associated with mortality and Armillariella tabescens (Scop, ex Fr.) Singer (Clitocybe tabescens Bres.), another root rot pathogen, in several sand pine (Pinus clausa (Chapm.) Vasey) plantations in north Florida and south Georgia. More recently, Barnard et al. (unpublished) have isolated P. cinnamomi from roots and/or soil from beneath 9 of 14 planted stands (plantations and seed orchards) suffering from root disease in north and north central Florida. On several occasions, this was the only known pathogen isolated from individual trees or individual stands. The fungus has not been found in any of 12 natural sand pine stands examined (9, 10, and Barnard et al., unpublished).

The pathogenicity of P. cinnamomi to seedlings of both the Choctawhatchee (P. clausa var. immuginata Ward) and Ocala (P. clausa var. clausa Ward) races of sand pine has been demonstrated by Ross and Marx (10). After 2 months in greenhouse tests, the pathogen killed up to 96 and 60% of test seedlings belonging to the Choctawhatchee and Ocala races respectively, depending upon treatment variables. In Florida, approximately 500,000 sand pine seedlings have been lost in one commercial forest nursery over the past 2 years due to outright mortality caused by P. cinnamomi and/or related quarantine of infected stock (Barnard, unpublished).

The complete role of P. cinnamomi in the etiology of sand pine root disease is not yet fully understood, particularly in stands where it occurs in association with other known or suspected root disease fungi (1, 9, 10). However, its documented pathogenicity, known distribution, and infamous history make this pathogen one of substantial importance to timber industries and others engaged in growing sand pine.

ORIGIN AND DISSEMINATION. The origin of P. cinnamomi is uncertain, but considerable evidence suggests that it may be an introduced pathogen in the United States, as it well may be in the jarrah forests of western Australia (3, 6, 7, 8, 12, 13). The fact that it has been found only in planted sand pine stands and not in natural stands is supportive of this view. Whether or not P. cinnamomi is native to sand hill sites requires confirmation, but the answer may hold significant keys to our understanding of sand pine root disease.

Regardless of origin, P. cinnamomi, like other soil-borne fungi, can be spread by movement of infected nursery stock, movement of infested soils on equipment, etc., surface movement of irrigation or rainwater and/or mycelial growth through contiguous root systems of suitable host plants (5, 6, 12, 13). In addition, the pathogen is capable of surviving for years in infested soils in the absence of a suitable host (5, 12). Effective control programs must consider these aspects of the pathogen's biology.

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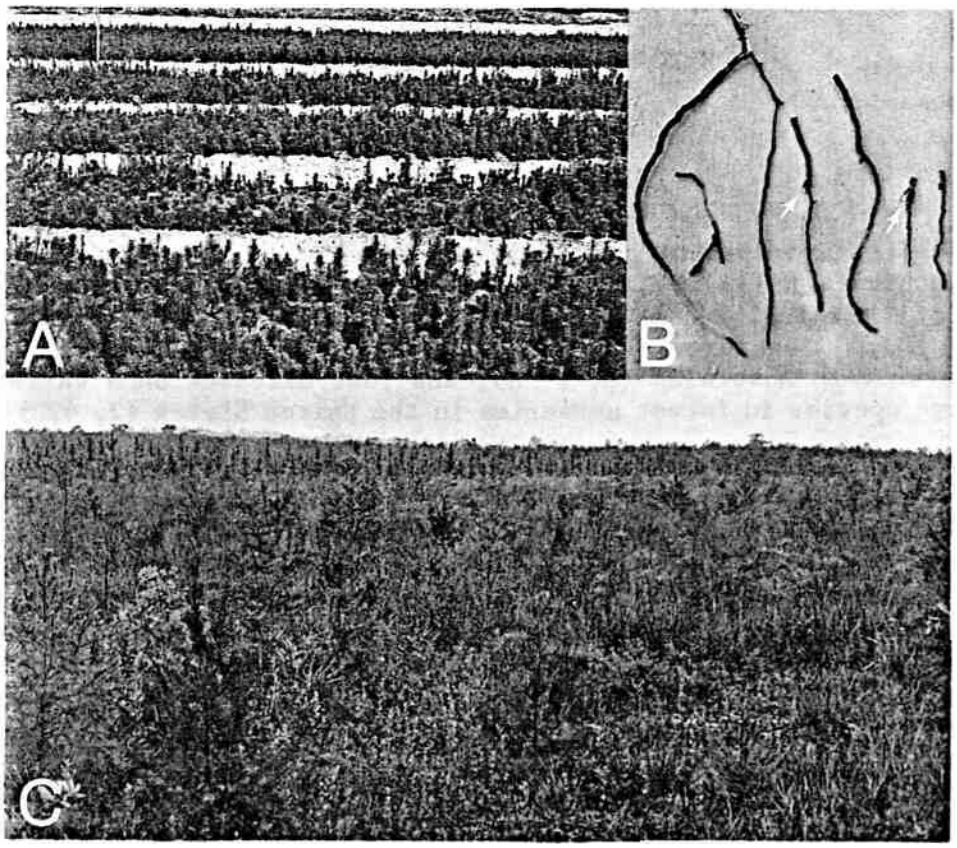

Fig. 1. Damage to sand pine caused by Phytophthora cinnamomi: A) mortality of seedlings in a forest tree nursery; B) infected feeder roots showing sloughing of darkened, necrotic cortex tissue, and adventitious root development (arrows); C) mortality in a 4-year-old plantation.

SURVEY AND DETECTION. In nursery seedbeds, severely infected seedlings exhibit discolored foliage ranging from a slight chlorosis to bright orange-red or brown with the onset of mortality (Fig. 1:A). Seedlings which are only lightly infected often fail to exhibit noticeable aboveground symptoms or simply remain stunted. Infected roots are typically darkened, and the necrotic cortical tissues of infected feeder roots are characteristically prone to sloughing, exposing the woody tissues of the stele. Adventitious root development, at points behind the advancing necrosis, is not uncommon (Fig. 1:B). Occasionally, tap roots and/or root collars are partially or fully impregnated with resin. This symptom may or may not be accompanied by external resinosis.

In the field, infected trees exhibit the same pattern of aboveground symptom development, although by virtue of seedling/tree size and/or other environmental factors, the interval between the onset of initial symptoms and eventual mortality may be extended (Fig. 1:C). In addition, some infected trees remain green, but show symptoms of decline or stress by a progressive thinning of their crowns. Infected roots in field situations usually exhibit some degree of external resinosis, and as a result, soil often adheres in clumps to roots of diseased trees. Sometimes external resinosis is evident on the stems of infected trees at or near the ground line. Internally, woody roots and root collars of diseased trees generally show some degree of resin impregnation. With increasing stand age, diseased trees become increasingly susceptible to windthrow due to the progressive loss of roots vital to their support. At this stage the involvement of other known or suspected root rot pathogens is common (1, 9, 10), and the specific roles of each in the root disease complex are less than completely understood.

Because only symptoms of P. cinnamomi infections are evident in nursery and field situations and these symptoms are not pathogen-specific, laboratory confirmation is essential for positive diagnosis.

CONTROL STRATEGIES.

1. Adequate fumigation of forest nursery seedbeds with an appropriate formulation of methyl bromide.
2. Regulatory methods including meticulous inspection and phytosanitary certification of nursery seedling crops, with the application of rigid quarantines where appropriate.
3. Avoid planting sand pine in environments which are conducive to the activity of the pathogen; i.e., heavy, poorly drained soils or soils with a shallow impervious layer.
4. Avoid movement of infested soils by adequately cleaning machinery, etc., which has been operating in areas of known pathogen activity.
5. Consider alternative, apparently less susceptible species (e.g., slash or longleaf pine) when regenerating sites where the pathogen's presence is known and such alternatives are silvicuturally acceptable.

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